id	session code	title	Presenter name	Affiliation
54	B-5-1	Impact assessment of terrain turbulence to wind turbine fatigu	Mr. Soichiro Kiyoki	Hitachi, Ltd.
9	B-5-2	Typhoon Wind Condition Analysis – A Case Study to the 2MW Wind Turbine during the Typhoon Soulder in 2015	Prof. Jui-hung Liu	Southern Taiwan University of Science and Technology
104	B-5-3	Bird Detection near Wind Turbines from High-resolution Video using LSTM Networks	Mr. Tu Tuan Trinh	Graduate School of Information Science and Technology, The University of Tokyo
179	B-5-4	Regional Center for Renewable Energy and Energy Efficiency Initiative for Environmental Risk Mitigation of Wind Power Projects Development Case Study: Egypt, Gulf of Suez	Dr. Ahmed Abdel Aziz Mohamed Badr	Regional Center for Renewable Energy and Energy Efficiency

Impact assessment of terrain turbulence to wind turbine fatigue

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Abstract:

There is a little flat land in Japan and wind farms constructed in complex terrain have been increasing as wind turbine becomes widespread. Thereby, the accident by fatigue failure resulted from terrain turbulence are increasing. To prevent it, it is necessary to consider fatigue accurately in the construction planning.

The method for evaluating fatigue at wind turbine construction site is being discussed in working group of IEC61400-15 and so on now. But it mainly targets for flat terrain and there are many unclear items in fatigue evaluation in complex terrain.

To consider the back ground above, we researched the feature of wind in complex terrain and the effect to wind turbine fatigue of it by field test and tried to develop the simulation tool to evaluate it.

The measurements were carried out on the wind turbine installed in complex terrain, which is located in about 5km land side of the coast. The targeted wind turbine is a 2MW downwind turbine made by Hitachi Ltd. Wind condition was measured by the anemometer and wind vane which is mounted on the nacelle and loads were measured by the strain gauges installed on flapwise at the root part of three blades. Here, downwind turbine is characterized in that the nacelle anemometer and wind vane is installed on the wind ward side of the rotor, it can be accurately measured than upwind turbine.

In this study, we focused on the east wind which is expected to be severe even in the wind condition of complex terrain. On the east side of the wind turbine, at a distance of about 370m, there is a mountain of the almost same height as the rotor upper end of the wind turbine. About wind speed, turbulence intensity exceeds the IEC category A and periodic fluctuation of the period 6s that seems to be due to the mountain wes observed. About wind direction, the standard deviation is more than 40deg, fast fluctuation of the period 1s and big wind direction change of more than 90deg were observed. As a result of their wind conditions, fatigue load becomes more than twice of the north wind which is the prevailing wind direction and higher than the planed value in IEC category A.

As an analysis tool for evaluating the fatigue load in complex terrain, we developed the method for linking the wind analysis software RIAM-COMPACT using LES model and aeroelastic analysis software for wind turbine BLADED. We almost succeeded in reproducing the spatial time series data of wind speed analyzed by RIAM-COMPACT as input of BLADED but some like the average horizontal shear could not be reproduced. The developed method represents a conservative result and fatigue load in east wind was about 1.7 times the actual measurement result.

Typhoon Wind Condition Analysis - A Case Study to the 2MW Wind Turbine during the Typhoon Soulder in 2015

Jui-hung Liu[1] and Jien-chen Chen[2]

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Abstract:

In 7th, August, 2015, Typhoon No.13 Soudelor passing directly through Taiwan from East side to West side. And lead to serious damages to two on shore wind farms located separately in north and middle Taiwan. In north Taiwan, the Shimen wind farm, in which 6 Vestas V47-660kW turbines were installed. One turbine tower break down and the other one's nacelle was severely damaged. In middle Taiwan, the Taichung wind farm, in which 21 Zephyros Z72-2MW turbines were installed since 2006. 6 turbines were totally break down and 1 turbine's blade damage. Investigations have been raised to find out the root cause of these events. It has been found that the maximum wind speed measured from the nearby Met is 61.8 m/s related to the hub height of Z72. Obviously, the wind speed exceeds the design wind class II, which is 59.5 m/s. However, this doesn't mean all damaged turbines experienced the same of higher wind impact during Typhoon. In this paper, wind conditions analysis were conducted to find the extreme point and the turbulent intensity in this period. And finally try to give a reasonable conclusion to this event from the viewpoint of the wind.

Bird Detection near Wind Turbines from High-resolution Video using LSTM Networks

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Abstract:

Wind energy - a low cost and renewable, non-polluting resource has grown rapidly in the last few years as human became increasingly concerned about environmental problems such as air pollutants and greenhouse gases. Although wind energy has much less impact on the environment compared to conventional power plants in terms of air and water pollution, there are many reports of bird mortality caused by wind turbines, due to collision with blades, loss of nesting and feeding grounds, and interference of migratory routes. These deaths will increase as turbines multiply, and are becoming serious threats to endangered species.

In order to carry out environmental assessments and evaluate this potential impact, demand for automatic bird detection system arises to collect large amount of bird data. Such system may also have practical use such as mitigating the damages by decelerating blades or making some specific sound to drive birds away.Image-based detection is one of the promising approaches for bird detection owing to the rich visual information that helps distinguishing birds from other moving objects, and detecting them in areas that cannot be detected by radar, such as ground surfaces or near wind turbines. Recently, Convolutional Neural Networks (CNN), one of the deep learning methods suitable for image recognition, have shown outstanding results in recognition tasks in still image data, since they can extract more hierarchical and data-suited features automatically compared to conventional hand-crafted features. However, the areas containing birds captured by static camera may have very low-resolution, and in bad weather they may even hardly recognized by human eyes. Moreover, distinguishing birds from hard negatives such as leaves, other flying objects, or blades is still challenging due to their visual similarities if the method is based only on appearance in one frame.

In fact, these problems sometimes can be easily solved when the motion is available. Several studies in computer vision followed this idea and showed that detection performance can be improved by incorporating motion features. However, most of previous studies brought in motion information only by inter-frame hand-crafted features and stack them for several frames. How to introduce automatic learning of motion features, and how to adaptively choose the number of frames is still in debate.

In this paper, we propose a detecting system combining CNNs and LSTMs (Long Short-term Memory Networks), which can leverage rich features extracted from CNNs and the ability of learning long-term dependencies and processing continuous information of the input video frames. LSTMs is one kind of recurrent neural networks, succeed in aggregating deep motion feature extracted from continuous frames and worked tremendously well on video recognition and video transcription tasks. We also constructed our own high-resolution video data taken near the wind farms in North Japan to evaluate our proposed method, and experimentally verified the improvement of our system’s performance compared to previous methods.

Regional Center for Renewable Energy and Energy Efficiency Initiative for Environmental Risk Mitigation of Wind Power Projects Development Case Study: Egypt, Gulf of Suez

Ahmed Abdel Aziz Mohamed Badr and Ali Mahmoud Khazma and Souhir Hammami

Regional Center for Renewable Energy and Energy Efficiency

Abstract:

Wind energy generation can play an important role in the reduction in the use of fossil fuels for energy production and therefore their associated greenhouse and toxic gas emissions and land use issues. However, wind energy developments require substantial

infrastructure to be placed across a landscape and where these turbines are inappropriately placed they may have a negative effect on birds and there is a need to balance the risks and benefits and to minimize any adverse environmental effects.

Egypt has set an ambitious plan to increase the contribution of renewable energy to 20% of generated electricity by 2022, with 12% from wind power plants to be installed mainly in Suez Gulf area due to its richness in wind resources. Gulf of Suez is located on one of the globally important flyways for migratory birds. Specialized studies and existing accumulated expertise in wind energy projects in that area point out to the possibility of significant impacts on soaring migratory birds.

In accordance with Egypt's related international obligations and conventions; and given the importance of the Red Sea flyway for Egyptian and global Avian populations; and recognizing that avoiding potential negative impacts on migratory soaring birds requires a common environmental management system on the entire area. The Regional Center for Renewable Energy and Energy Efficiency (RCREEE) have taken the initiative of developing an executive framework for a Strategic Cumulative Environmental and Social Assessment (SESA) of wind energy projects, complemented by a post-construction program to monitor migratory birds and active management of wind turbines during bird migration seasons spring and autumn.

The active turbine management program aims to ensure environmental, protection and risk mitigation strategy, while increasing the feasibility and the wind turbines productivity.

RCREEE has succeeded in launching the study and providing a coordinating and executive strategic framework among three governmental institutions through a protocol to facilitate cooperation on one hand, on the other RCREEE signed cost sharing agreements with Gulf of Suez international wind developers. Several international financial institutions has been involved in all the project discussions.

This paper presents the result of joint efforts among RCREEE as an intergovernmental organization, governmental institutions and private sector in the implementation of the first Active Turbine Management Program (ATMP) on mega scale planned for five coming years.